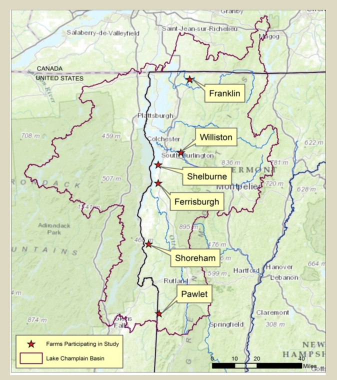
STRATEGIES FOR SAMPLING EDGE-OF-FIELD RUNOFF

Dave Braun, Stone Environmental, Inc.

1. STUDY BASICS

Objective:
To test the effects of certain conservation practices on event discharge and nutrient and sediment export in surface runoff from agricultural fields

Location:
14 paired runoff monitoring stations on six farms in the Vermont portion of the Lake Champlain Basin



Duration:
Sept. 2012 – Nov. 2014 (6 stations)
Sept. 2012 – Nov. 2015 (8 stations)

Participating Agencies:
USDA-NRCS
VT Agency of Agriculture, Food, and Markets
VT Dept. of Environmental Conservation
Lake Champlain Basin Program

2. PROBLEM STATEMENT

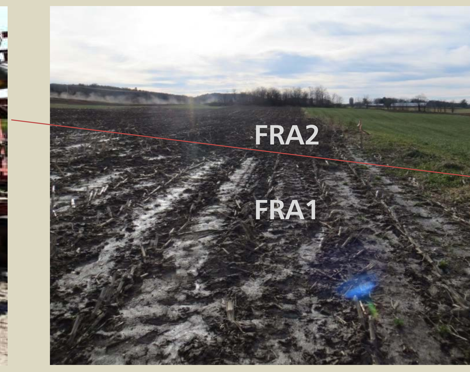
Agriculture is a major contributor of phosphorus (P) to Lake Champlain. Although federal and state programs, as well as farmers, have made unprecedented investments in agricultural conservation practices; however, these efforts have not yet yielded desired water quality results. There is an urgent need to evaluate the effectiveness of conservation practices in the Lake Champlain Basin so that the most effective may be emphasized. This edge-of-field monitoring study was initiated in 2012 to evaluate conservation practices being promoted in the Lake Champlain Basin.

3. CONSERVATION PRACTICES TESTED

1. Soil aeration on hayland prior to manure (Ferrisburgh, Shelburne, and Shoreham)
2. Cover cropping on silage corn (Pawlet)
3. Reduced tillage and manure injection on cornland (Franklin and Williston)
4. Water and sediment control basin treating runoff from a cornfield (Franklin)

Coming soon: Grassed waterway study

Participating farmer explains his manure injection system

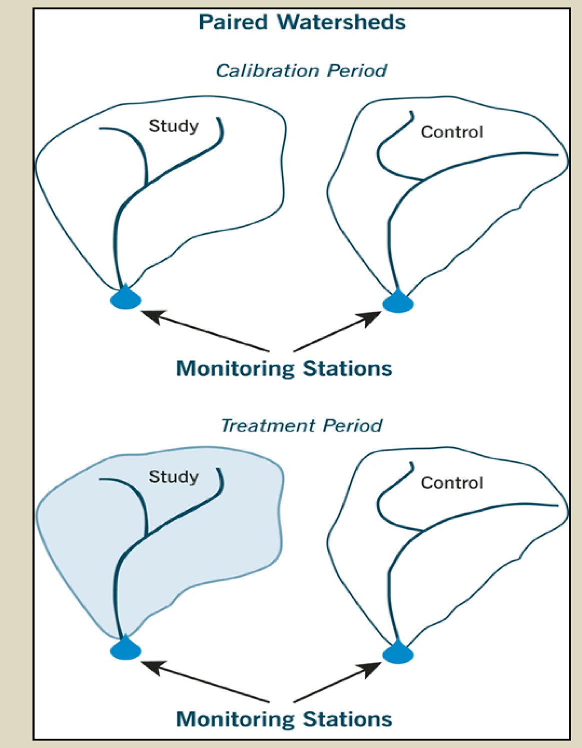


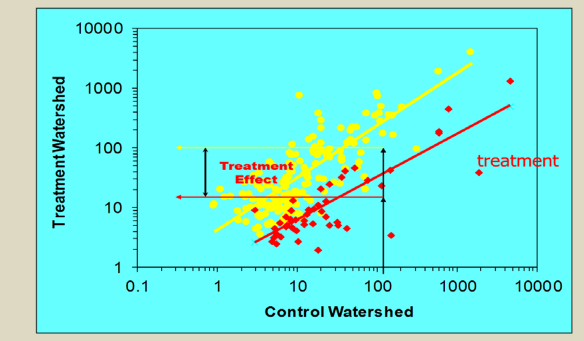
Field after manure injection in FRA1 and chisel plowing in FRA2

4. PAIRED WATERSHED DESIGN

The study design and procedures are consistent with NRCS monitoring practice standard (Code 799).

A paired-watershed design is being used to document the effects of conservation practices on runoff losses of nutrients and sediments at the field scale. The paired-watershed design includes a control and a treatment watershed. The control watershed accounts for year-to-year climate variations and the management practices remain consistent during the entire study. The treatment watershed undergoes a change in management during the study. The basis of the paired-watershed approach is that there is a quantifiable relationship (i.e., a linear regression model) between paired data from the watersheds (calibration) and that this relationship is valid until a change is made in one of the watersheds (treatment). At that time, a new relationship will exist. The difference between the calibration and treatment relationships is used to evaluate and quantify the effect of treatment.



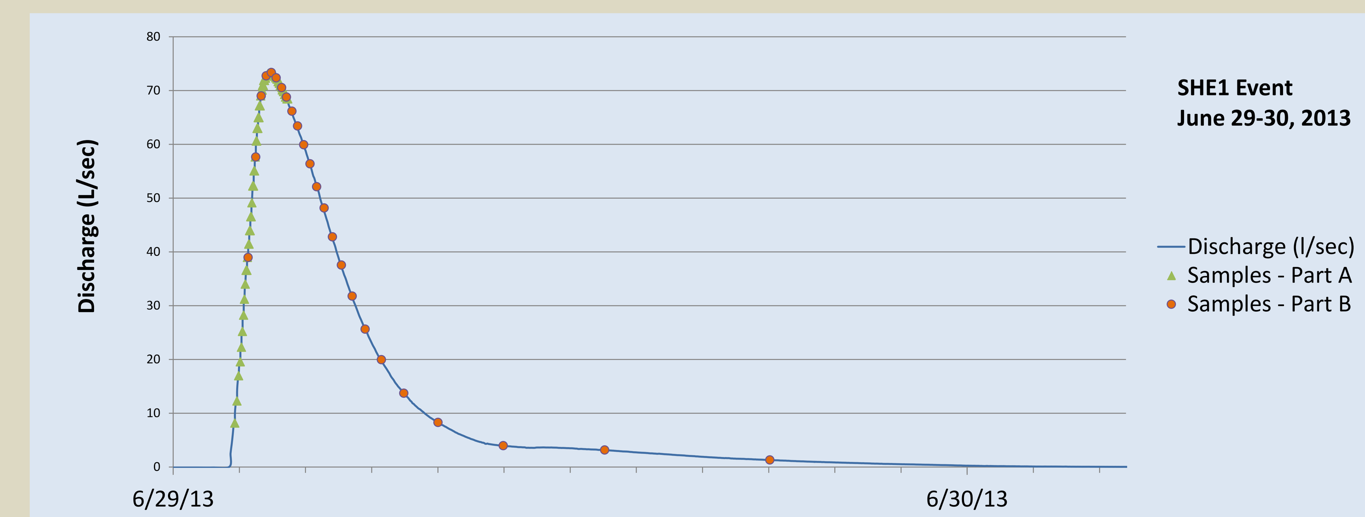


5. MONITORING STRATEGIES

In designing the monitoring program and systems, our main strategies were: 1) to produce representative samples from runoff events of greatly varying magnitude, and 2) to simplify procedures to enable personnel with limited training to process samples and reset stations after runoff events.

Operational details:

1. Flow-proportional runoff samples are composited in 10-L carboys. Only one or two carboys are processed for each event, greatly reducing sample handling, analytical cost, and data processing needs relative to time-paced sampling programs.
2. Two-part autosampler programs are used, specific for each station based on discharge data. At a typical station, the autosampler dispenses a sample to the Part A carboy every 500 – 1,000 L. Simultaneously, the autosampler dispenses a sample to the Part B carboy every 5,000 - 20,000 L. In small events, the Part A carboy is the more representative sample and the Part B sample is discarded. In large events, the Part B carboy is more representative and the Part A carboy (which will have filled prematurely) is discarded. Due to the two-part autosampler pacing and the large capacity of the carboys, events varying in magnitude by a factor of 400 may be representatively sampled.
3. Autosampler settings may be adjusted (via remote command) for changes in field conditions; however, this is rarely necessary due to the two-part programs.
4. Samples are processed in the field, increasing permissible holding times. Sample splits are analyzed for TP, TDP, TN, TDN, TSS, and chloride.
5. Cellular modems push field data to a computer server in near real time, enabling personnel to track the progress of runoff events (by viewing a dedicated website) to better time field visits. This also enables early detection of instrument malfunctions and eliminates need to download instruments.
6. When the water level in the flume reaches the sampling threshold (1 cm), sampling personnel are alerted via text message that a runoff event has begun.
7. Autosamplers are controlled remotely when necessary, often to avoid operation during freezing conditions.



Example of sampler pacing using two-part program (Station SHE1)

6. MONITORING INSTRUMENTS

- H-flume (1.5, 2, or 2.5 foot)
- ISCO 2110 ultrasonic flowmeter for continuous measurement of stage in the flume and calculation of flow rate
- ISCO 6712 autosampler with custom bottle manifold
- Onset Hobo tipping bucket rain gage
- ISCO 2105-Ci Interface Module with cellular telephone modem

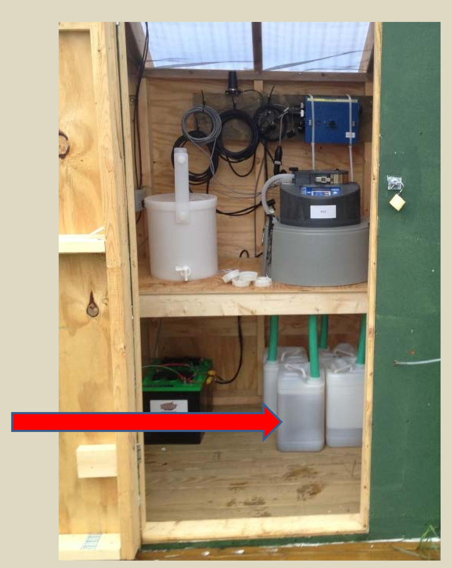
7. SELECTED RESULTS

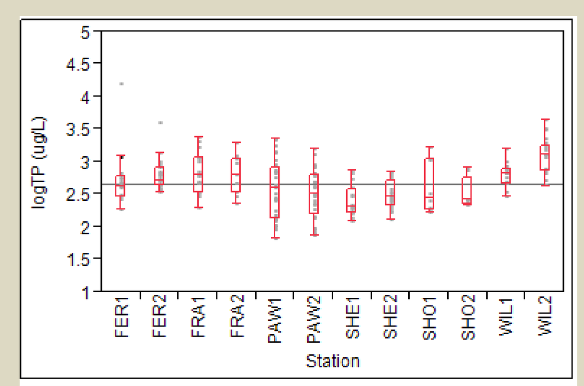
The program is successfully measuring discharge and collecting representative runoff samples. Enough paired events have been monitored for statistical calibration at most sites for most parameters: 76 of 78 regressions are significant at $P < 0.10$; 71 of 78 regressions are significant at $P<0.01$

Station	Number of Paired Flow Events[1]	Number of Paired Chemistry Events
Ferrisburgh	19	16
Franklin	17	11
Pawlet	40	28
Shelburne	24	20
Shoreham	11	6
Williston	18	15

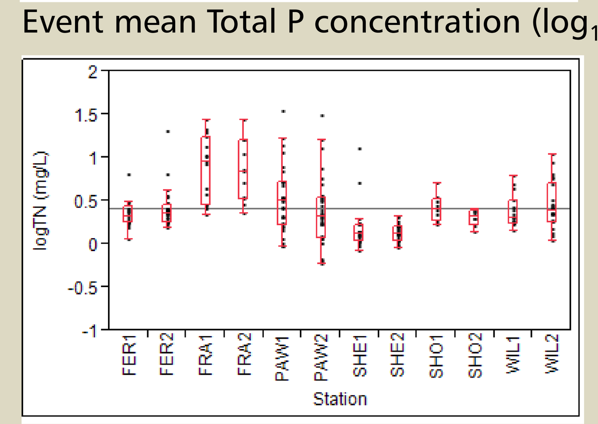
1. Includes only events with measureable runoff and valid data at both stations in a pair

Q_{event}
x
$E_{vent}M_{ean}C_{onc.}$
=
Mass Load

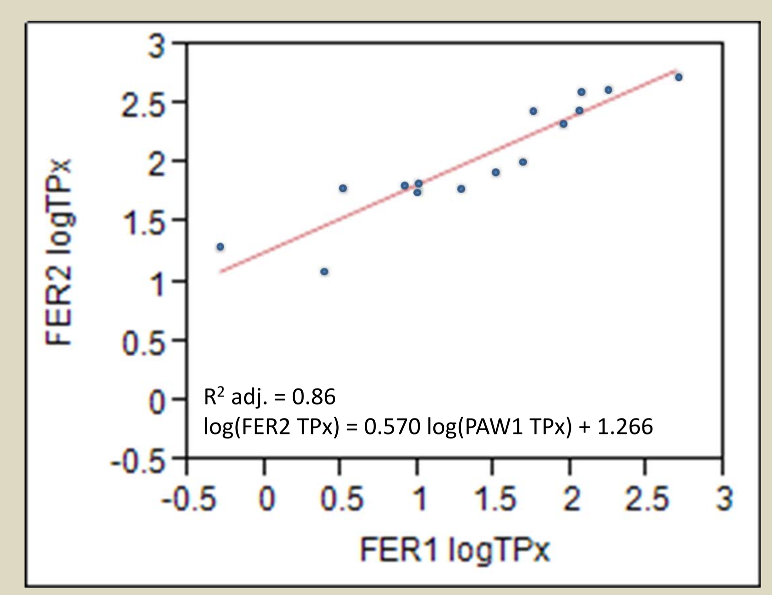




Event mean Total P concentration (log_{10})



Event mean Total N concentration (log_{10})



Example of regression analysis on paired watershed data: Total P export at Ferrisburgh site

8. EXPECTED OUTCOMES

- Accurate estimates of pollutant reductions achievable by several agricultural conservation practices in Vermont-specific climate, landscape, and management settings;
- Scientifically sound data on conservation practice performance in support of TMDLs and other pollution reduction programs;
- Data that inform incentive programs to ensure that the most effective practices are emphasized; and
- Identification of potential modifications to conservation practices that may improve performance.